THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 19

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte REZA R. AGAHI
and BEHROOZ ERSHAGHI

Appeal No. 1997-0287
Application 08/263,034[1]

HEARD: October 4, 1999

Before JERRY SMITH, BARRETT, and BARRY, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

DECISION ON APPEAL

[1] Application for patent filed June 21, 1994, entitled "Shaft Bearing System."

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 5, 11, and 14-18. Claims 1-4, 6-10, 12, and 13 have been canceled.

We affirm.

BACKGROUND

The disclosed invention is directed to a fluid thrust balancing system combined with a turbo-machine[2] having active magnetic thrust bearings. The fluid thrust balancing system augments and complements the active magnetic thrust bearings.

Claim 5 is reproduced below.

5. A turboexpander comprising:

a turboexpander housing;

a radial inlet into said turboexpander housing;

an axial outlet from said turboexpander housing;

a turboexpander rotor in said turboexpander housing;

a compressor housing;

an axial inlet into said compressor housing;

a radial outlet from said compressor housing;

[2] A "turbo-machine" is defined as: "A machine of special design intended for high speed operation." The New IEEE Standard Dictionary of Electrical and Electronics Terms (1993).

a compressor rotor in said compressor housing;

a shaft mounting said turboexpander rotor and said compressor rotor;

active magnetic thrust bearings positioned about said shaft between said turboexpander rotor and said compressor rotor;

a discontinuity on said shaft for measuring axial displacement of the shaft;

a proximity sensor adjacent said discontinuity to locate said discontinuity axially relative to said active magnetic thrust bearings;

a control passage extending from a low-pressure zone in said axial inlet to a high-pressure zone between said compressor housing and the back of said compressor rotor;

a control valve in said control passage; and

a controller coupled with said proximity sensor and said control valve and responsive to the axial position of the turboexpander shaft as detected by said proximity sensor to regulate said control valve.

The Examiner relies on the following prior art:

Swearingen (Swearingen '689)	3,895,689	July 22, 1975
Swearingen (Swearingen '768)	4,385,768	May 31, 1983
Andres et al. (Andres)	5,310,311	May 10, 1994
Miura et al. (Miura)	5,312,226	May 17, 1994
New	5,345,127	September 6, 1994 (filed July 14, 1993)

Claims 5, 11, and 14-18 stand rejected under 35 U.S.C. § 103 as being unpatentable over Andres and either Swearingen '689 or Swearingen '768. The Examiner's rejection is as follows (Paper No. 5, pages 2-3, incorporated by reference into the Final Rejection, Paper No. 9):

> Andres teaches providing a combination of a turboexpandes [sic, turboexpander] and turbocompressor on a single shaft. It is noted that this combination per se is admittedly prior art (see applicants['] specification pages 1-7). Andes [sic, Andres] utilizes magnetic bearings for both the compressor and expands [sic, expander]. Swearington [sic, Swearingen] teaches that for a turbo expands [sic, expander] or compressor it is advantageous to utilize fluid bearings that can better adjust to (automatically compensate) [for] thrust variations. For at least this reason it would have been obvious to one of ordinary skill in the art to incorporate the fluid bearings of Swearington [sic, Swearingen] into either the expands [sic, expander] or compressor of Andres.

Claims 5, 11, and 14-18 also stand rejected under 35 U.S.C. § 103 as being unpatentable over Andres and either Miura or New. The Examiner's rejection is as follows (Paper No. 5, page 3, incorporated by reference into the Final Rejection, Paper No. 9):

> As noted above Andres teaches the basic system except for the specific bearings. Miura and New both teach using a combination of magnetic and fluid bearings to take advantage of the unique attributes of each type. Note that use of redundant systems is a matter of routine cost/benefit: is the added cost of the back-up system

> justified via the increased safety/protection? For at least the reasons taught by New and Miura it wold [sic] have been obvious to use a combined fluid and magnetic bearing system in Andres.

We refer to the Office Action entered April 4, 1995 (Paper No. 5), the Final Rejection (Paper No. 9) (pages referred to as "FR__"), and the Examiner's Answer (Paper No. 12) (pages referred to as "EA__") for a statement of the Examiner's position and to the Appeal Brief (Paper No. 11) (pages referred to as "Br__") and the Reply Brief (Paper No. 13) (pages referred to as "RBr__") for a statement of Appellants' arguments thereagainst.

OPINION

It is admitted that turbo machinery having a turboexpander and compressor was well known (specification, pages 1-2). It is admitted (specification, page 3): "Two primary types of bearings that may be used to support the rotor shaft in turbo machinery are magnetic bearings and oil film bearings. Magnetic bearings provide superior performance over oil film bearings." It is admitted that active magnetic radial and thrust bearings were conventional (specification, page 10) and that use of a proximity sensor and a discontinuity on the shaft for measuring axial displacement

was conventional (specification, page 11). The Examiner cites Andres as evidence of this conventional structure. Andres discloses everything in claims 5, 11, and 14 except for the fluid thrust balancing structure of a control passage, a control valve, and a controller, and the limitation in claim 11 that "said controller only regulates said control valve when said thrust bearing current exceeds 20% of said maximum value of said thrust bearing current."

It is admitted that turbo machinery having mechanisms for adjusting thrust loading in conjunction with conventional thrust bearings are known as illustrated by Swearingen '689 and Swearingen '768 (specification, page 2). Swearingen '689 and '768 show a passage, a control valve, and a controller for controlling the axial thrust in response to detection of the axial position by a position detector.

The issue is whether it would have been obvious to one of ordinary skill in the art to combine a fluid thrust balancing system (i.e., a passage, control valve, and controller for adjusting thrust loading) with turbo machinery having active magnetic thrust bearings.

The Examiner's rejection seems to misapprehend the issue. The Examiner concludes that "it would have been obvious to one of ordinary skill in the art to incorporate the fluid bearings of Swearington [sic, Swearingen] into either the expands [sic, expander] or compressor of Andres" (Paper No. 5, pages 2-3) and "it wold [sic] have been obvious to use a combined fluid and magnetic bearing system in Andres" (Paper No. 5, page 3). Thus, the rejection goes to adding backup fluid bearings (which are not claimed) rather than a backup fluid thrust balancing system. Nevertheless, it appears from Appellants' Brief that Appellants interpret the intended rejection to be addition of a fluid thrust balancing system to Andres (e.g., "Andres et al. does not teach, suggest or imply use of a compressor for fluid thrust balancing as the asserted combination by the Examiner of this base reference with other references implies" (Br9-10)).

Andres and New

Initially, we find that New does not disclose a fluid thrust balancing system for rotary equipment and, thus, cannot make obvious the claimed subject matter when combined with Andres. New discloses passages 60, 116 for providing

pressurized fluid to hydrostatic journal bearings 50, 51 and thrust bearings 52, 53 as backup for magnetic journal bearings 20, 21 and magnetic thrust bearings 22, 23 to support the shaft temporarily. The source of the pressurized fluid may be taken from the process fluid outlet duct 15 by the fluid line 62_1. The hydrostatic bearing system does not provide a control passage between a high-pressure zone and a low-pressure zone to control the axial displacement of the rotor. Accordingly, the rejection of claims 5, 11, and 14-18 over Andres and New is reversed.

Andres and Swearingen '689 or Swearingen '768

Swearingen '689 and Swearingen '768, which are assigned to the assignee of the present application and disclosed as prior art (specification, page 2), disclose turbo machinery having mechanisms for adjusting thrust loading in conjunction with conventional thrust bearings. Swearingen '689 and '768 show a passage between high- and low-pressure zones, a control valve in the passage, and a controller for controlling the axial thrust by opening and closing the valve. Swearingen '689 controls the valve based on sensing the pressure of oil between the thrust bearing parts, which is a measure of axial

thrust and axial displacement. Swearingen '768 controls the valve based on sensing the axial shaft position. Swearingen '689 and '768 do not disclose the fluid thrust balancing system in combination with active magnetic thrust bearings.

Swearingen '689 and '768 indicate that the problem of variations in axial thrust on the shaft of high speed rotating machinery such as "compressors, turbines, turboexpanders" (Swearingen '689, col. 1, line 15; see also Swearingen '768, col. 2, lines 3-4) was known. The solution in the patents is to use a fluid balancing system using a control valve to balance the pressure between high-pressure and low-pressure zones to offset the thrust on the bearings. The fluid thrust balancing system is independent of the type of bearings. One of ordinary skill in the art would have recognized that the same problem of axial thrust exists in turbo machinery having active magnetic bearings such as Andres and would have been motivated to employ a fluid thrust balancing system as taught in Swearingen '689 or Swearingen '768 in addition to the active magnetic thrust bearings to offset the thrust load on the thrust bearings. Thus, Andres and either Swearingen '689 or Swearingen '768 appear to be sufficient to establish a

prima facie case of obviousness. We consider Appellants' arguments before deciding whether a prima facie case has been made.

Appellants argue that "[i]n a number of places, fluid balancing with what are termed air bearings are discussed in Andres et al." (Br10) and that "the Andres et al. patent specifically denigrates any fluid thrust system for maintaining axial position against thrust, thereby teaching away from the use of such air bearings" (Br11). The portions of Andres pointed out by Appellants refer to fluid bearings not to fluid thrust balancing by venting between high- and low-pressure zones, which are the claim limitations at issue. A "bearing" refers to a combination of stationary and rotating members in which a shaft is supported and may rotate, where the stationary and rotating members may support a load by various means, such as balls, hydrodynamic fluid films, or magnetic fields. "Thrust balancing" refers to venting between high- and low-pressure zones and is not a bearing. Andres says nothing about a fluid thrust balancing system; the Swearingen patents are relied on for this feature. Therefore,

Appellants' arguments that Andres teaches away and must be avoided as a reference are not persuasive.

Appellants argue that the two Swearingen patents provide no teaching or suggestion of magnetic bearings (Br11). However, Andres is relied on for its teaching of active magnetic thrust bearings and a compressor in association with other turbo-machinery. One cannot show nonobviousness by attacking the references individually where the rejection is based on a combination of references. In re Keller, 642 F.2d 413, 426, 208 USPQ 871, 882 (CCPA 1981). Similarly, the argument that "[n]one of the references aside from Andres et al. provide any system using magnetic bearings with a compressor in association with other turbomachinery" (Br15) is not persuasive because the rejection is based on a combination of references. The argument that "[n]one of the references provide a compressor system to supply differential pressure to a fluid thrust balancing system for other turbomachinery where the shaft uses magnetic thrust bearings" (Br15) are not persuasive because it essentially argues lack of anticipation where the rejection is based on obviousness.

Appellants argue (Br15): "Looking to the specific claim groups, claim 5 further requires a turboexpander as another rotary device. Turboexpanders are not provided in the prior art presented. Only Andres et al. discloses a turbine." The Swearingen patents expressly state that the fluid thrust balancing system is applicable to turboexpanders. When Appellants state that "[o]nly Andres et al. discloses a turbine" (Br15), it is not clear whether Appellants are admitting or denying that Andres has a turboexpander. Since the turbine of Andres serves to expand air which is pressurized by the compressor (abstract), we find that Andres teaches a turboexpander in combination with a compressor.

Appellants argue (Br16): "Claims 5, 11 and 16 specifically provide for the use of the back side of the compressor rotor. Andres et al. and New fall short." Presumably Appellants admit, as they must, that the Swearingen patents and Miura disclose using the high pressure from the back side of the compressor rotor. Andres is not relied on for fluid thrust balancing and so it has never been contended that it teaches using the high pressure from the back side of

the compressor rotor. The rejection over Andres and New has been reversed, so the argument with respect to New is moot.

Insofar as Appellants contend that there is no express suggestion in the cited art that the references be combined to render the appealed invention obvious, such argument improperly isolates the teachings of the individual references and ignores well established law that obviousness is determined by reference to the level of skill of one having ordinary skill in the art. The Federal Circuit has stated:

> [T]he language that there must be some teaching, reason, suggestion, or motivation "in the prior art" or "in the prior art references" to make a combination to render an invention obvious within the meaning of 35 U.S.C. § 103 (1988) . . . if taken literally would mean that an invention cannot be held to have been obvious unless something specific in a prior art reference would lead an inventor to combine the teachings therein with another piece of prior art.
>
> This restrictive understanding of the concept of obviousness is clearly wrong. . . .
>
> I believe it would better reflect the concept of obviousness to speak in terms of "<u>from</u> the prior art" rather than simply "<u>in</u> the prior art." The word "from" expresses the idea of the statute that we must look at obviousness through the eyes of one of ordinary skill in the art and what one would be presumed to know with that background.
>
> . . . While there must be some teaching, reason, suggestion, or motivation to combine existing elements to produce the claimed device, it is not necessary that the

> cited references or prior art specifically suggest making the combination. . . . Such suggestion or motivation to combine prior art teachings can derive solely from the existence of a teaching, which one of ordinary skill in the art would be presumed to know, and the use of that teaching to solve the same or similar problem which it addresses.

In re Oetiker, 977 F.2d 1443, 1447-48, 24 USPQ2d 1443, 1446 (Fed. Cir. 1992) (Nies, C.J., concurring). It is not required that there be an express suggestion in Andres to use a fluid thrust balancing system or an express suggestion in the Swearingen patents to use the fluid thrust balancing system in a turbo machine having active magnetic thrust bearings. One of ordinary skill in the art of designing turbo machinery would have known that the turbo machine having active magnetic bearings in Andres had the same problem of variations in axial thrust as the machine in the Swearingen patents and would have been motivated to use the fluid thrust balancing system of the Swearingen patents for the same reason of offsetting the thrust on the bearings.

For the reasons discussed above, we conclude that Appellants have not shown that the rejection is based on insufficient evidence of prima facie obviousness. See In re Rouffet, 149 F.3d 1350, 1355, 47 USPQ2d 1453, 1455 (Fed.

Cir. 1998) ("On appeal to the Board, an applicant can overcome a rejection by showing insufficient evidence of prima facie obviousness or by rebutting the prima facie case with evidence of secondary indicia of nonobviousness."). The rejection of claims 5 and 14-18 over Andres and either Swearingen '689 or Swearingen '768 is sustained.

Claim 11 recites "said controller only regulates said control valve when said thrust bearing current exceeds 20% of said maximum value of said thrust bearing current." The first time the Examiner mentions this limitation is in the Examiner's Answer where it is stated that "it has long been held that developing optimization of a device is within the skill expected of the routineer and therefore obvious" (EA4).

We agree with Examiner that optimization of variables known to be result effect variables would have been within the level of skill of one of ordinary skill in the art. However, there must first be some teaching or suggestion in the prior art or the knowledge of one of ordinary skill in the art that identifies the variable as a result effective variable. The Swearingen patents do not disclose or suggest a threshold limitation to prevent hunting, nor has the Examiner pointed to

any knowledge within the level of ordinary skill in the art. Accordingly, the rejection of claim 11 over Andres and either Swearingen '689 or Swearingen '768 is reversed.

Andres and Miura

Miura discloses a turbo compressor having an axial thrust balancing mechanism comprising a passage 29 between a balancing chamber 33 and the suction nozzle inlet 24, a control valve 30 in the passage, and a controller comprising the circuitry in figure 1, which is responsive to an axial displacement signal from the position detector sensor 34 to regulate the control valve. Miura discloses that the turbo compressor uses an active magnetic thrust bearing 28 which is also controlled by the axial position detector sensor 34. Miura states (col. 8, lines 15-33):

> In accordance with this embodiment, this control operation is consecutively repeated to prevent occurrence of a large thrust force acting on the thrust bearing even if the operation conditions are changed. Thus, the thrust force produced to act on the rotor can be controlled through the steady and transient operations so as to be prevented from being excessively increased, whereby the size of magnetic thrust bearing 28 can be reduced. If the size of the magnetic thrust bearing can be reduced, a reduction in the rotating mass outside the journal magnetic bearing 27 as well as a reduction in the axial length of the shaft can be achieved, thereby facilitating supporting a turbo compressor by means of a

> magnetic thrust bearing, which turbo compressor is conventionally supported by oil bearings. A complete magnetic bearing system can be thereby achieved to realize an oil-free design and, hence, an economical turbo compressor reduced in running cost, maintenance cost or the like.

Thus, Miura discloses an active magnetic thrust bearing system and fluid thrust balancing system in combination with a turbo compressor, where the fluid thrust balancing system is for the purpose of reducing the thrust on the active magnetic thrust bearings. Miura also discloses that the fluid thrust balancing controller and active magnetic thrust bearing controller are coupled together.

One of ordinary skill in the art of designing turbo machinery would have recognized that the same problem of variations in axial thrust exists in turbo machinery having active magnetic bearings such as Andres and would have been motivated to employ a fluid thrust balancing system as taught in Miura in addition to the active magnetic thrust bearings to offset the thrust load on the thrust bearings. The combination of Andres and Miura appears sufficient to establish a prima facie case of obviousness. We consider Appellants' arguments before deciding whether a prima facie case has been made.

Appellants' arguments regarding Andres have been discussed in connection with the rejection over Andres and the two Swearingen patents and are not persuasive.

Appellants argue that Miura's arrangement where both magnetic thrust bearings and fluid thrust bearings are employed to regulate the axial disposition of the compressor shaft is "in direct contradiction to Andres et al." (Br11). This argument is not commensurate in scope with the claims which do not preclude a fluid thrust backup bearing system. Miura teaches that it was known to have an active magnetic thrust bearing system in combination with a fluid thrust balancing system.

Appellants further argue with respect to Miura that (Br11-12): "No other thrust loading rotary devices are understood to be associated with the shaft. In terms of the present invention, it is a system without something to balance but the balancing system itself." Miura discloses that the compressor alone creates a thrust imbalance, so Appellants' argument that there is nothing to balance in Miura is without merit. One of ordinary skill in the art would have recognized that turbo machinery, such as Andres, having other turbo

machinery in association with a compressor on a shaft would have the same problem of thrust imbalance and would have been motivated to use a thrust balancing system as taught in Miura.

For the reasons discussed above, we conclude that Appellants have not shown that the rejection is based on insufficient evidence of prima facie obviousness. The rejection of claims 5 and 14-18 over Andres and Miura is sustained.

With respect to claim 11, Miura states (col. 6, line 66, to col. 7, line 2): "An [sic] dead band 52 is provided in the control line to the control valve 30 to correct the opening of the control valve only when the deviation signal becomes greater than a certain level, thereby preventing hunting." Thus, Miura discloses a threshold, but does not disclose a particular value for the threshold. One of ordinary skill in the art, knowing that a threshold value should be selected to prevent hunting is presumed to have had sufficient skill to determine a specific value by routine experimentation. See In re Boesch, 617 F.2d 272, 276, 205 USPQ 215, 219 (CCPA 1980) ("[D]iscovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of

the art."). Because the thrust bearing current is proportional to the position deviation signal, it would have been obvious to regulate the control valve dependent upon the thrust bearing current rather than the deviation signal. We do not find any arguments by Appellants as to the threshold teaching of Miura or any arguments that the 20% number is somehow critical. The rejection of claim 11 over Andres and Miura is sustained.

CONCLUSION

The rejection of claims 5 and 14-18 over Andres and either Swearingen '689 or Swearingen '768 is sustained. The rejection of claim 11 over Andres and either Swearingen '689 or Swearingen '768 is reversed.

The rejection of claims 5, 11, and 14-18 over Andres and Miura is sustained.

The rejection of claims 5, 11, and 14-18 over Andres and New is reversed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a).

AFFIRMED

JERRY SMITH Administrative Patent Judge	)
LEE E. BARRETT Administrative Patent Judge	) BOARD OF PATENT APPEALS AND INTERFERENCES
LANCE LEONARD BARRY Administrative Patent Judge	)

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